SAP system virtualization with HP ProLiant servers – total cost of ownership and return on investment with VMware vSphere

Virtualization as a business enabler

Technical white paper

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Executive summary

Server consolidation, lowering the total cost of ownership (TCO) of IT assets, green IT, IT as a service and business enabler, and IT agility are topics that are being widely discussed in the industry. SAP systems administrators cannot ignore the fact that colleagues are increasingly using virtualization to address such issues.

This white paper from HP SAP Solutions Engineering on the virtualization of Microsoft® Windows®-based SAP systems (see also "SAP system virtualization with HP ProLiant servers – an introduction") outlines the business case for virtualization, describing economic, environmental, and technological drivers. To demonstrate many of the problems associated with aging, traditional SAP landscapes, this paper reviews a TCO study of such an environment, then proposes a new, virtualized landscape that, based on an investment of $1,257,785, could generate savings of over $2,800,000 in the first three years of operation. This investment would pay for itself in only ten months, freeing up funds for value-added projects.

Not only are its business values compelling, virtualizing an SAP landscape can also lower your impact on the environment. Even a smaller implementation – such as that described in this white paper – can reduce overall requirements for space, power, and cooling.

Note

The TCO and return on investment (ROI) metrics used in this paper are based on server performance estimates and are intended to show how virtualization can impact TCO and ROI.

Target audience: The audience for this white paper includes HP technical pre-sales personnel, SAP consultants, and partners. Readers should be familiar with VMware and SAP products.

Note

Where appropriate, footnotes refer to a citation in the Bibliography that provides a link to additional information on a particular topic. Such footnotes include a reference (for example: **HP, 2008d**) that allows you to locate the desired citation.

Introduction

In a news release, Mark Potter, senior vice president and general manager, Infrastructure Software and Blades, HP said[1]: "*For more than half a decade, HP and VMware have jointly invested in technologies that enable customers to maximize the value of their virtualization efforts. By extending virtualization beyond servers through HP's converged infrastructure solutions, customers can fully realize the potential of their people, applications and technology infrastructure.*"

Only HP can deliver a complete, end-to-end virtualization solution that combines hardware, software and services to help solving the most pressing issues and problems of today's IT departments, such as:

- Data centers are not optimized for IT agility (or, therefore, business agility)
- Because of aging systems and labor-intensive IT activities, most of the IT budget is being consumed by maintenance and operations
- Power and space are being used inefficiently in the data center
- Power and cooling costs are high

HP is a global leader in VMware technologies[1] with the most VMware-certified server and storage systems and the largest number of VMware-certified professionals supporting heterogeneous environments. HP also offers customers the largest global VMware Authorized Training Center network, with more than 100 training centers in more than 30 countries.

This section outlines a range of drivers for virtualization.

Economic drivers

Key economic drivers for virtualization are the requirements for data centers to be more competitive, faster, and better able to adapt to changing business needs, such as responding to new customer demands or overcoming the results of the ongoing financial crisis.

Environmental drivers

Along with addressing economic drivers, it is becoming increasingly important for businesses to understand that they must depend on resources like power, water, and space. However, the growth in data center capacity is exhausting these natural resources by increasing the demand for electrical energy for power and cooling. Indeed, HP scientists have projected[2] that "*business technology consumes 415 million tons of coal per year with 864 million tons of CO^2 greenhouse emissions.*"

Reducing the negative impact of increases in computing power has become a shared responsibility. Note, however, that promoting environmental-friendliness can not only reduce your carbon footprint but may also lower energy costs and, thus, free up your IT budget. In addition, a growing body of legislation may also require you to reduce your consumption of natural resources.

By supporting the consolidation of multiple physical servers, virtualization has become a key mechanism for reducing the consumption of natural resources. Indeed, HP claims[3] that energy costs in the data center can be reduced by 50% – 60% by implementing HP technologies like Dynamic Smart Cooling and Dynamic Power Capping in conjunction with the virtualization and consolidation of servers and storage on later-generation HP ProLiant servers and HP storage systems.

[1] Cp. website: http://www.hp.com/hpinfo/newsroom/press/2009/090901a.html?jumpid=reg_R1002_USEN, date of access: 06.01.2010
[2] Cp. (HP, 2007), HP white paper "Energy efficiency for the enterprise", page 1
[3] Cp. (HP, 2007), HP white paper "Energy efficiency for the enterprise", page 2

Technological drivers

While technological innovations and developing trends force CIOs to constantly re-think their IT strategies, virtualization creates a paradigm shift that can deliver modular, manageable, cost–effective, agile systems.

Rather than dedicating a physical server to a particular application, you can now utilize a VM on a shared host system. Benefits include:

- Standardize server system deployments
- Reduce physical server sprawl
- Create headroom for growth
- Improve resource utilization
- Support dynamic resource configuration
- Reduce power and cooling usage

To help make a business case for virtualization, this section outlines the costs associated with a legacy SAP landscape and shows how a new, virtualized landscape can significantly reduce TCO.

TCO of a legacy SAP landscape

Addressing changing business needs requires an agile IT infrastructure that is able to keep pace. However, SAP landscapes exclusively implemented using legacy servers tend to be rather static and are not sufficiently flexible react in a timely matter to such changes.

Before making a business case for replacing a legacy landscape with virtualized, consolidated servers, you must first be able to quantify the TCO of the legacy systems. This section presents a TCO study of an existing SAP landscape that highlights some of the problems and costs associated with a legacy implementation and helps build a business cases for a new, virtualized landscape.

A later section of this white paper proposes a pair of virtualized, consolidated solutions designed to replace the legacy landscape and details TCO/ROI studies of these solutions (see TCO/ROI study of a virtualized landscape).

Performing a TCO study

This TCO study is based on the analysis of a monthly report used to monitor resource utilization on the legacy systems. The configurations of the legacy servers are presented in Appendix A – Legacy servers.

Tool used for the study

The HP Alinean Enterprise ROI calculator[4], developed by Alinean, Inc.[5], was used to perform TCO and ROI studies described in this white paper. The independent financial model developed by Alinean can help you estimate the TCO, potential cost savings, and ROI of an infrastructure solution designed to replace an existing infrastructure.

The tool uses costs (such as server hardware and energy costs) that are updated by IDC[6] on a monthly basis.

[4] Cp. (HP, 2009f), HP tool: "HP Enterprise ROI"
[5] Cp. www.alinean.com
[6] Cp. website: www.idc.com, date of access: 11/02/2009

Existing legacy landscape

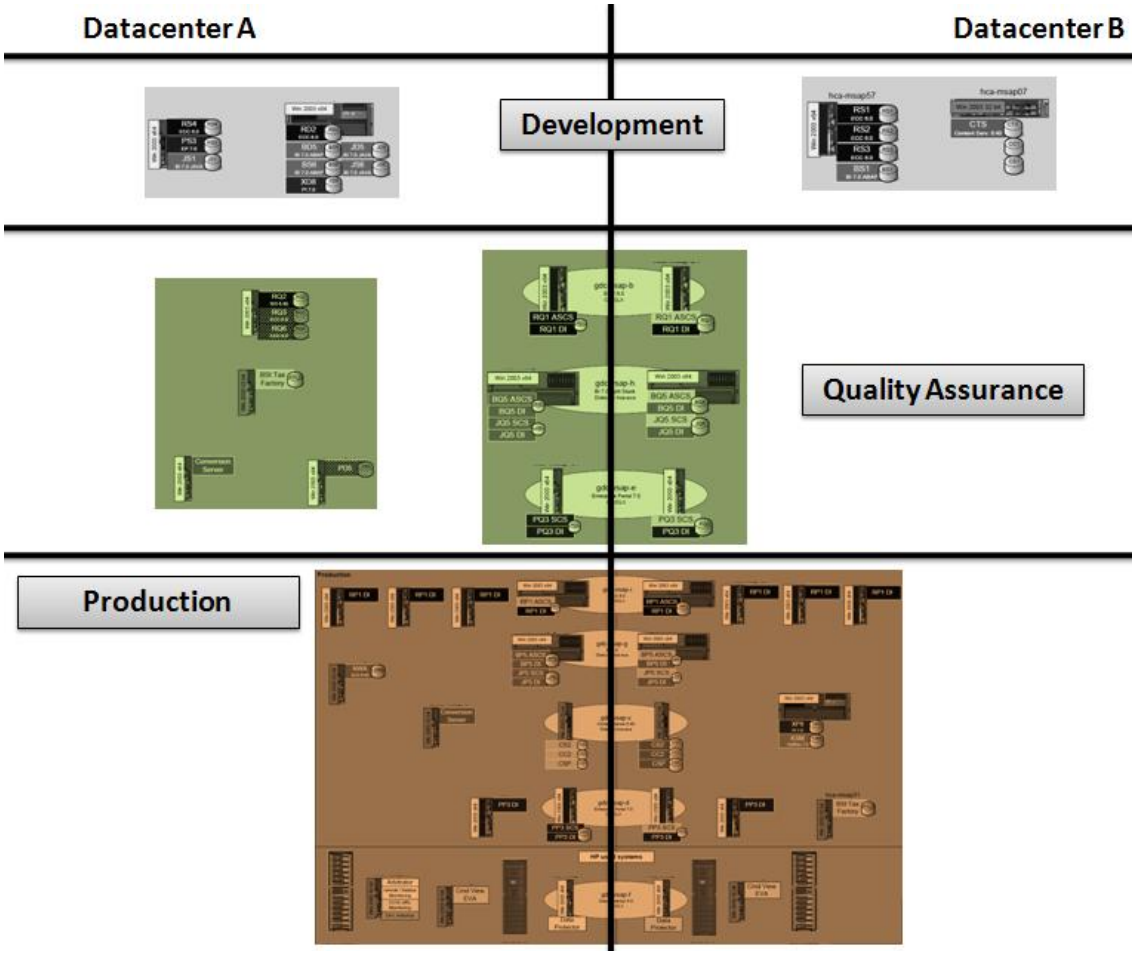
The legacy SAP landscape includes development, QA, and production systems distributed between two data centers (Datacenters A and B). This separation of systems, along with the use of clustering and replication technologies, results in a highly-available SAP landscape.

In each two-node cluster, the SAP application runs on one node, with the database on the second node. If a node were to fail, the application and database are designed to run on the surviving node.

The landscape consists of legacy HP ProLiant servers installed in 2005 – 2008. These servers are equipped with dual- or quad-core AMD Opteron™ or Intel® Xeon® processors, and are running x64 versions of Windows Server 2003 Enterprise or R2 Enterprise Edition. Shared data storage is provided by an FC-connected HP StorageWorks Enterprise Virtual Array (EVA) storage solution; internal disks are used for the OS.

Figure 1 provides a simplified view of the legacy landscape.

Figure 1: Simplified view of the existing legacy SAP landscape



The configurations and resource utilization levels of the 38 servers deployed in this landscape may be summarized as follows:

- Number of CPU cores – 190
- Average[7] CPU utilization – 10.32% of total capacity

[7] Average figures were obtained by summing the values for individual servers and dividing by 38.

- Installed memory – 1,234 GB, with an average of approximately 32 GB per server
- Average probability of a memory bottleneck[8] – 6.55%
- Installed storage – 54,214 GB, with an average of approximately 1,427 GB per server
- Storage utilization – 42,544 GB, or 78%
- Average disk I/O utilization – 15.26%

Thus, servers are poorly utilized; memory and I/O resources are sufficient. While the amount of storage used is relatively high, an archiving solution may help to reduce storage requirements.

Note
For more information on the legacy SAP landscape, see Appendix A – Legacy servers .

Calculating the TCO

HP used the HP Alinean Enterprise ROI calculator to estimate the costs associated with running the legacy landscape. This tool allows you to customize the configuration of the SAP landscape being evaluated.

The TCO calculated by this tool uses the following categories when calculating costs:

- Current server configuration (purchase price)
- Hardware and software support contract costs
- Storage costs
- Server and software upgrades to handle growth
- IT operations and administration staff costs (see Appendix C – IT operations)
- Facilities costs
- Downtime costs

The HP Alinean Enterprise ROI calculator is populated with manually-entered data along with pre-loaded industry, location, and size research data developed by Alinean[9] in conjunction with third-parties like IDC.

Specifying server models

Since original pricing for the legacy servers is unknown, the HP Alinean Enterprise ROI calculator was required to provide and use approximate prices. However, since the tool does not support a mixed server landscape featuring HP ProLiant BL and DL server line models, HP decided to specify BL models, consolidating the eight server models deployed in the legacy landscape to two models – BL25p and BL45p – based on average price.

The HP Alinean Enterprise ROI calculator only considers price; neither performance nor capacity factor into its calculations. Thus, HP was able to select the server classes shown in Table 1 to best represent the average cost of servers purchased for the legacy landscape. When available, actual purchase prices make this methodology more accurate.

Table 1 lists the different server models used in the legacy landscape along with approximate prices based on information provided by the HP website and other sources.

[8] Memory bottleneck probability is a function of the following metrics: physical memory used, page-out request rate, and page request rate. On a normally loaded system, this probability should be below 75%.
[9] Cp. website: www.alinean.com, date of access: 11/02/2009

Table 1: Legacy servers with approximate purchase prices

Quantity	HP ProLiant server model	Approximate purchase price	Total price
1	DL380 G3	$5,150	$5,150
2	BL45p G2	$21,500	$43,000
8	BL25p G1	$5,000	$40,000
2	DL585 G2	$26,100	$52,200
11	BL45p G1	$21,500	$236,500
6	DL580 G5	$22,200	$133,200
6	BL20p G2	$7,200	$43,200
2	BL25p G2	$6,200	$12,400
Total			**$565,650**

Based on the pricing shown in Table 1, HP was able to consolidate the various legacy servers using two HP ProLiant server blade models that are supported by the HP Alinean Enterprise ROI calculator:

- **BL25p** ($6,000) – 1 x DL380 G3, 8 x BL25p G1, 6 x BL20p G2, and 2 x BL25p G2, for a total of 17
- **BL45p** ($22,125) – 2 x BL45p G2, 2 x DL585 G2, 11 x BL45p G1, and 6 x DL580 G5, for a total of 21

Estimated prices used by the HP Alinean Enterprise ROI calculator are based on 2 GB – 4 GB of RAM. Since the legacy servers deployed in this example have more memory installed, HP increased the average server price by $5,000 to reflect original purchase prices more realistically.

Table 2 shows the estimated pricing for the legacy environment based on two representative server models with additional memory.

Table 2: Average purchase prices using representative server models

Quantity	Item	Price
17	HP ProLiant BL25p server blade	$102,000
21	HP ProLiant BL45p server blade	$464,625
1	Additional cost for larger memory configuration (38 x $5,000)	$190,000
Total		$756,625

Using the TCO tool

In the Questionnaire section of HP Alinean Enterprise ROI calculator, the tool was configured with the **Quick and High-Level** profile.

In the Solution Selection section of the tool, it is important to select **As-is for Solution A**, the only setting that allows the ROI calculation for the new landscape to be compared with the existing legacy landscape.

Individual profiles for the BL25p and BL45p server blades were specified as either **Application** or **Database** type; in general, the **Application** profile was used for infrastructure systems.

As shown in Figure 2, the additional memory costs (required to supplement the 2 GB – 4 GB assumed by the tool) were entered as a separate line item with a cost of $190,000.

Since the legacy SAP landscape includes an FC-SAN environment that can be re-used in the new, virtualized landscape, storage costs were not included in the calculation.

Figure 2: Data entered into the HP Alinean ROI calculator's questionnaire

Current Server Configuration	Server type	Number of Servers	Average Purchase Price (per server)
HP BL25p 2.6GHz 1MB 2GB (2)	Database	10	$6,000
HP BL45p 2.6GHz 4GB (4)	Database	21	$22,125
HP BL25p 2.6GHz 1MB 2GB (2)	Application	7	$6,000
None	Application	0	$0
Additional costs for large memory configuration, per server $5,000		1	$190,000
		0	$0
		0	$0
		0	$0
		0	$0
Total (all servers)		**39**	**$756,625**

Table 3 shows the estimated TCO of the existing legacy landscape as calculated by the HP Alinean Enterprise ROI calculator. In a later section (see TCO/ROI study of a virtualized landscape), this TCO is compared to that of a new, virtualized landscape based on fewer, later-generation HP ProLiant servers.

Table 3: Annual TCO of the existing legacy landscape

Item	Estimated annual cost
IT costs	
Server hardware	$92,624
Server software	$8,241
IT operations and administration staff (see Appendix C – IT operations)	$782,087
Facilities	$37,614
Change	$0
Hardware and software support and maintenance	$713,535
Total	**$1,634,101**
Business operating costs	
Unplanned downtime – Impact on end-user productivity during business hours	$125,173
Planned downtime – Impact on end-user productivity during non-business hours	$11,458
Security-related downtime – Impact on end-user productivity during business hours	$38,670
Total	**$175,301**

Continued

Table 3: Annual TCO of the existing legacy landscape (continued)

Item	Estimated annual cost
Business strategic costs	
Unplanned downtime – Impact on business during business hours	$15,309
Planned downtime – Impact on business during non-business hours	$1,401
Security-related downtime – Impact on business	$4,730
Business agility – Cost of lost opportunities	$44,140
Total	**$65,580**
TCO	**$1,874,982**

For a detailed explanation of the different cost categories, refer to the HP Alinean Enterprise ROI calculator web site.[10]

TCO/ROI study of a virtualized landscape

HP sized[11] two different virtualized solutions – one based on rack-mount HP ProLiant servers; the other on an HP BladeSystem infrastructure – that are capable of replacing the legacy SAP landscape described above. These solutions are based on VMware vSphere virtualization software.

To minimize TCO and shorten ROI, the virtualized solutions have been optimized. To provide N+1 redundancy, you would require an addition server or server blade, depending on the particular configuration. The additional system would increase TCO and extend ROI.

Note
Omitting the redundant server or server blade is acceptable because many of the SAP production systems have very low utilization levels, thus freeing up resources.

The two virtualized solutions are configured as follows:

- Two HP ProLiant DL785 G6 servers to host VMs and two HP ProLiant DL385 G6 servers to deliver non-virtualized infrastructure services
- Four HP ProLiant BL685c G6 server blades to host VMs and two HP ProLiant BL465c G6 server blades to deliver non-virtualized infrastructure services

For more information on these solutions, refer to Appendix B – Servers in the new landscape.

Using DL785 G6 hosts

Instead of 38 legacy servers, it now only requires four physical servers – two hosts and two infrastructure/management servers – to deploy the SAP landscape, reducing by almost 90% the number of servers needed. Moreover, since failover clusters have been superseded by VMware High Availability (HA) (see Appendix D – Advanced VMware vSphere functionality), it has been possible to eliminate eight cluster nodes and, thus, eight application[12] instances.

By reducing the original 34 SAP instances to 27, you can expect a significant reduction in licensing and management costs.

[10] https://alinean.austin.hp.com/roianalyst/AuthenticateLogin.do
[11] A proprietary methodology was used
[12] Seven SAP instances (2 x ECC, 2 x EP, 2 x BI, 1 x Content Server) and one HP Data Protector instance

Note
Due to their low utilization rates, it is possible you could eliminate or consolidate some of the remaining SAP instances, further reducing your licensing and management costs.

As in the legacy environment, physical servers are distributed between two data centers to provide failure-tolerance at the site level. Data replication is assumed.

Figure 3 shows the migration from the legacy SAP landscape to the new, virtualized landscape. For simplicity, storage subsystems have been omitted.

Figure 3: Simplified view of the migration from the old SAP landscape to a new, virtualized landscape featuring DL785 servers

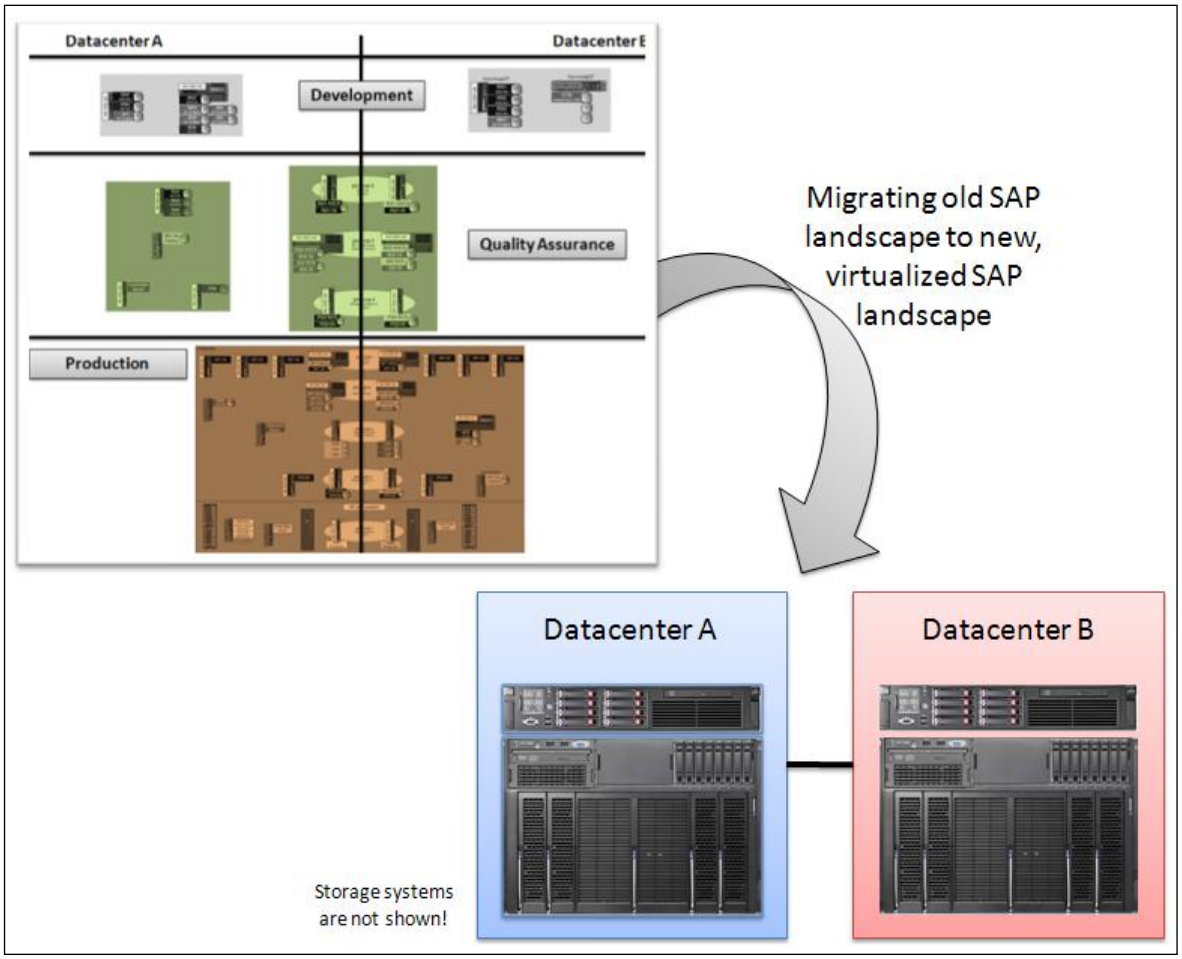


Table 4 (next page) provides more information about the new SAP landscape.

Table 4: New SAP landscape featuring DL785 G6 and DL 385G6 servers

Item	Role	SAPS*	Quantity	Total list price
HP ProLiant DL785 G6 server	VMware ESX 4.0 host	45,350	2	$134,000
VMware vSphere Enterprise Plus Acceleration Kit for 8 Processors			2	$63,876
HP ProLiant DL385 G6 server	Infrastructure services (such as management and backup)		2	$26,316
			Total	**$224,192**

*Benchmark, SAP ECC 6.0, EHP 4.0

While Table 4 does not include the cost of operating systems for the VMs, the HP Alinean Enterprise ROI calculator automatically adds Windows license costs to TCO/ROI calculations. Nevertheless, when virtualizing a large number of systems, you should consider obtaining a Windows Server Datacenter license, which provides unlimited support for Windows-based VMs. A Windows Server Datacenter license is less expensive than individual licenses if you virtualize more than 30 systems.

Furthermore, Table 4 does not reflect storage or network requirements since appropriate components from the legacy landscape are being re-used. However, the TCO of the new landscape is actually lower from the perspective of storage and networking for the following reasons:

- Thin provisioning reduces overall storage requirements
- Fewer network and storage ports are required

Note
Network and storage requirements are not included in the TCO/ROI calculations presented below.

TCO/ROI calculations for the new landscape

After the server sizing and selection process is complete, you can use the HP Alinean Enterprise ROI tool to calculate and compare the TCOs of the legacy and new landscapes. Finally, you can calculate the ROI of the new landscape to determine how quickly your investment will break even.

TCO/ROI calculations for the new DL785 server-based landscape are outlined below.

The HP Alinean Enterprise ROI calculator bases its calculations on average costs and list prices that may not reflect the actual costs involved in implementing a particular landscape. The calculations are intended to highlight the potential cost savings of virtualization, rather than providing precise results.

Since the HP Alinean Enterprise ROI calculator does not necessarily have access to the latest hardware and software costs, you can customize the tool using prices listed in Table 4. Simply click on the appropriate **Average Cost** fields for the new landscape (Solution B) and enter updated values.

Figure 4 shows updated pricing for DL785 and DL385 server hardware; Figure 5 for virtualization software (vSphere Enterprise in this example).

Figure 4: Updated server hardware costs

Solution B: SAP on HP ProLiant DL Server Systems				
Server Census	**Server Model**	**Number of Servers**	**Average Cost per Server**	**Total Cost (servers*cost)**
User presentation tier	HP ProLiant DL385 G2 (2U) Opteron 2222 3.0GHz 1MB (2ch/4co)	2	$13,158	$26,316
Application tier	None	0	$0	$0
Database (or combination) tier	HP ProLiant DL785 G5 (7U) Opteron 8384 2.7GHz (8ch/32co)	2	$67,000	$134,000
Development servers	None	0	$0	$0
Test servers	None	0	$0	$0
Total		4		$160,316

Figure 5: Updated software costs

	Solution A			Solution B		
Initial Software Licensing Costs (other than OS)	**Units**	**Average Cost per Unit**	**Total Cost (units * cost)**	**Units**	**Average Cost per Unit**	**Total Cost (units * cost)**
Application - user licensing	5,000	$0	$0	5,000	$0	$0
Application - server licensing	0	$0	$0	0	$0	$0
Database	16	$24,999	$399,984	16	$24,999	$399,984
Systems management	6	$2,199	$13,194	4	$2,199	$8,796
Disaster recovery		$9,000	$9,000		$6,000	$6,000
Virtualization Software	0	$4,396	$0	16	$3,992	$63,872
Total			$0			$478,652

TCO comparison

After updating hardware and software costs, you can use the HP Alinean Enterprise ROI calculator to compare the TCOs of the old and new SAP landscapes.

Table 5 presents the results of a cumulative three-year TCO comparison between old (Solution A) and new (Solution B) landscapes. Average, annualized figures are shown.

Table 5: TCO* comparison

Item	**Solution A**	**Solution B**	**Difference (A - B)**	**Difference (A - B)%**
IT costs				
Server hardware	$277,873	$194,876[13]	$82,997	29.9%
Server software	$24,723	$486,650[14]	<$461,927>	<1,868.4%>
IT operations and administration staff[15]	$2,346,261	$85,749	$2,260,512	96.3%
Facilities	$112,842	$28,333	$84,509	74.9%
Change costs	$0	$576,259	<$576,259>	0.0%
Hardware and software support and maintenance	$2,140,605	$289,858	$1,850,747	86.5%
Total	$4,902,304	$1,661,725	$3,240,579	66.1%

Continued

[13] Includes projected network costs of $34,560; thus, hardware costs are $160,316 (from Figure 4) + $34,560
[14] Costs include generated initial server OS licensing costs of $7,998; thus software costs are (from Figure 5) + $7,998
[15] See Appendix C – IT operations

Table 5: TCO* comparison (continued)

Item	Solution A	Solution B	Difference (A - B)	Difference (A - B)%
Business operating costs				
Unplanned downtime - End user productivity impact during business hours	$375,520	$45,114	$330,406	88.0%
Planned downtime - End user productivity impact during non-business hours	$34,375	$30,079	$4,296	12.5%
Security-related downtime - End user productivity impact during business hours	$116,010	$110,853	$5,157	4.4%
Total	$525,905	$186,046	$339,859	64.6%
Business strategic costs				
Unplanned downtime - Business impact during business hours	$45,927	$5,518	$40,409	88.0%
Planned downtime - Business impact during non-business hours	$4,204	$3,679	$525	12.5%
Security-related downtime - Business impact	$14,189	$13,558	$631	4.4%
Business agility - Opportunity cost	$132,420	$132,420	$0	0.0%
Total	$196,740	$155,175	$41,565	21.1%
Overall total	**$5,624,949**	**$2,002,946**	**$3,622,003**	**64.4%**

*TCO analysis calculations do not include realization risk adjustments from the calculator's Analysis Options settings for direct/indirect costs (although most Indirect line items include a discount on list prices), deployment schedule, or adoption curve.

According to the HP Alinean Enterprise ROI calculator, the most significant benefit of virtualizing the legacy SAP landscape is the reduction of IT operations and administration staff costs by 96.3% ($2,260,512) over a three-year period.

The HP Alinean Enterprise ROI calculator predicts a 64.4% TCO benefit over the next three years after implementing the new SAP landscape. Thus, it is 64.4% less expensive to run the new landscape, even after factoring in the cost of implementation.

Figure 6 presents a graphical comparison of costs associated with the legacy and virtualized landscapes.

Figure 6: Three-year, cumulative TCO comparison between legacy and new, DL785 server-based landscapes

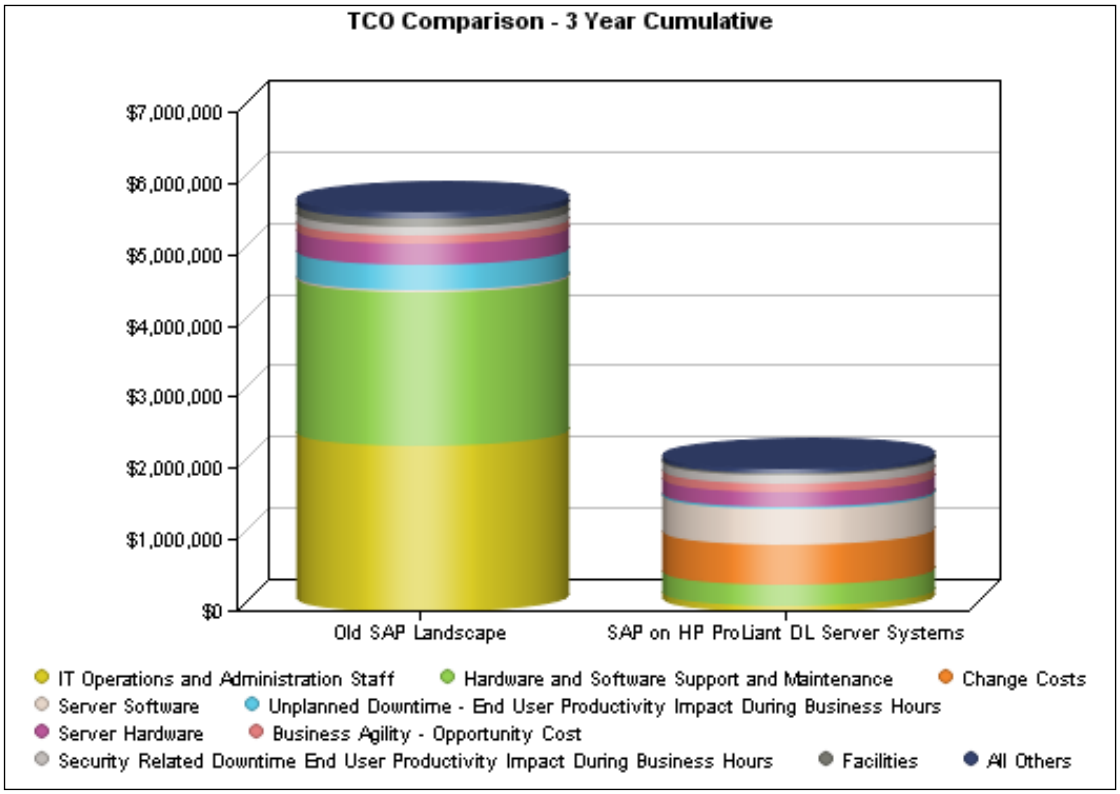


Table 6 presents the results of a three-year cost-benefit analysis, showing that the new, virtualized SAP landscape would save you $4,788,222 in direct (hard) costs and $381,424 in indirect (soft) costs.

Table 6: Three-year cost- benefit analysis

Item	Year 1	Year 2	Year 3	Total
IT cost reductions (direct)				
IT operations and administration staff[16]	$753,504	$753,504	$753,504	$2,260,512
Hardware and software support and maintenance	$687,690	$713,364	$739,551	$2,140,605
Server hardware	$90,796	$92,612	$94,465	$277,873
Facilities	$27,614	$28,166	$28,729	$84,509
Server software	$8,078	$8,240	$8,405	$24,723
Total	$1,567,682	$1,595,886	$1,624,654	$4,788,222

Continued

[16] See Appendix C – IT operations

Table 6: Three-year cost- benefit analysis (continued)

Item	Year 1	Year 2	Year 3	Total
Business operating efficiency (indirect)				
Unplanned downtime - End user productivity impact during business hours	$107,962	$110,121	$112,323	$330,406
Security-related downtime - End user productivity impact during business hours	$1,685	$1,719	$1,753	$5,157
Planned downtime - End user productivity impact during non-business hours	$1,404	$1,432	$1,460	$4,296
Total	$111,051	$113,272	$115,536	$339,859
Business strategic advantage (indirect)				
Unplanned downtime - Business impact during business hours	$13,204	$13,468	$13,737	$40,409
Security-related downtime - Business impact	$206	$210	$215	$631
Planned downtime - Business impact during non-business hours	$172	$175	$178	$525
Total	$13,582	$13,853	$14,130	$41,565
Summary				
Direct benefits	$1,567,682	$1,595,886	$1,624,654	$4,788,222
Indirect benefits	$124,633	$127,125	$129,666	$381,424
Total advantage for new SAP landscape	**$1,692,315**	**$1,723,011**	**$1,754,320**	**$5,169,646**

ROI calculation

Now that the HP Alinean Enterprise ROI calculator is aware of initial and ongoing costs for both legacy and virtualized SAP landscapes, it can perform an ROI study.

Note

The time taken to achieve ROI should be as short as possible. Investments with a negative ROI should not be entertained.

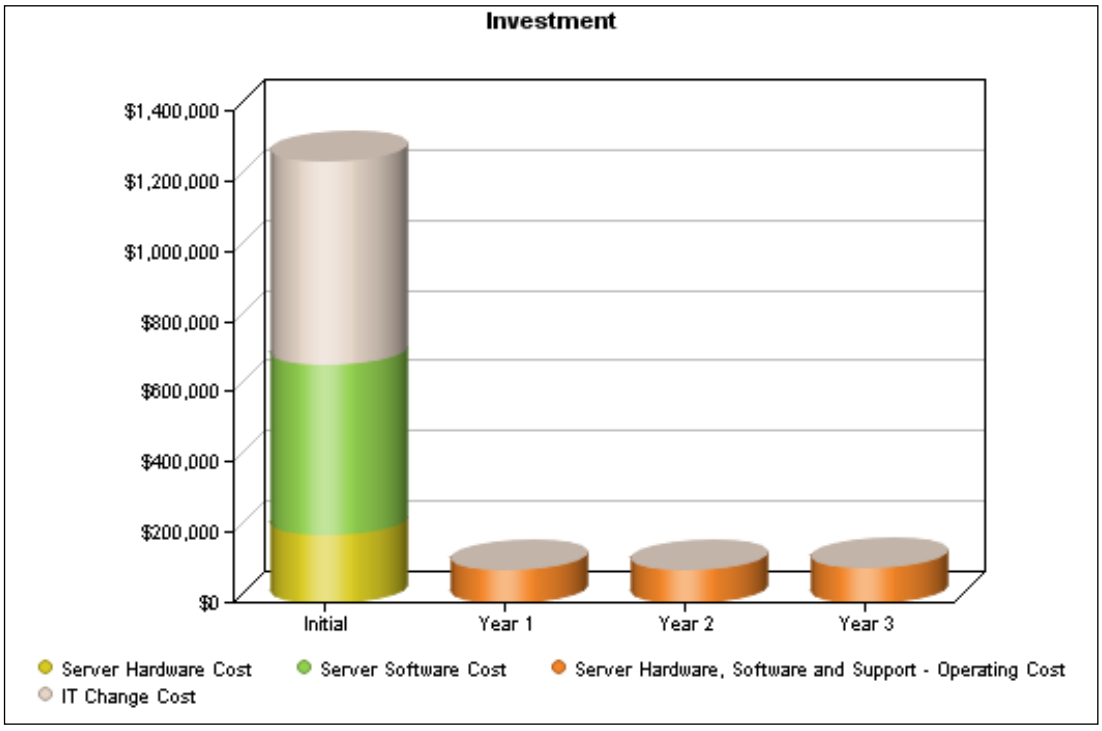
Table 7 summarizes your investment in the new landscape over the first three years. The tool estimates that your investment would total $1,547,643 for this period; that is, $1,257,785 capital expenditure and $289,858 in operating costs. By comparison, hardware support and maintenance costs alone for the legacy landscape are projected to be $2,140,605 for the same period.

Table 7: IT investment summary over three years

Item	Initial	Year 1	Year 2	Year 3	Total
Capital investment					
IT change cost	$576,259	$0	$0	$0	$576,259
Server software cost	$486,650	$0	$0	$0	$486,650
Server hardware cost	$194,876	$0	$0	$0	$194,876
Total	$1,257,785	$0	$0	$0	$1,257,785
Operating investment					
Server hardware, software, and support - Operating cost	$0	$94,712	$96,607	$98,539	$289,858
Total investment	**$1,257,785**	**$94,712**	**$96,607**	**$98,539**	**$1,547,643**

Figure 7 provides a graphical view of the distribution of your investment over the first three years. At more than $576,259 (45%), IT change is the highest-cost item, followed by software licensing costs at $486,650. Hardware costs are relatively low, at $194,876 (approximately 16%).

Figure 7: Investment summary over three years



ROI analysis

The HP Alinean Enterprise ROI calculator analyzed the costs associated with the legacy and virtualized landscapes, and developed the following metrics for the virtualized landscape:

- ROI: 234%
- Risk-adjusted ROI (RA ROI): 188%
- Net present value (NPV) savings: $2,818,784
- Internal rate of return (IRR): 115%
- Time taken to break even: 10.0 months

Table 8 summarizes this analysis.

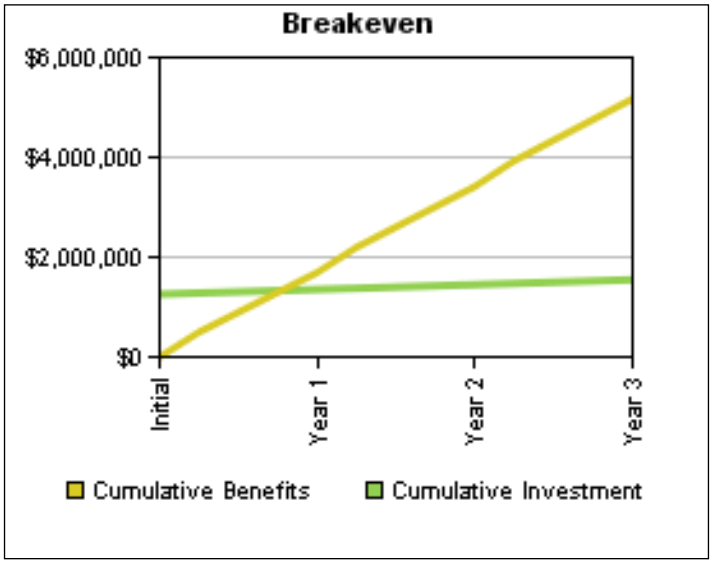
Table 8: ROI analysis

Item	Initial	Year 1	Year 2	Year 3
Annual TCO advantage over existing landscape	$0	$1,692,315	$1,723,011	$1,754,320
Cumulative TCO advantage	**$0**	**$1,692,315**	**$3,415,326**	**$5,169,646**
Annual investment in new landscape	$1,257,785	$94,712	$96,607	$98,539
Cumulative investment	**$1,257,785**	**$1,352,497**	**$1,449,104**	**$1,547,643**
Annual cash flow* for new landscape	<$1,257,785>	$1,597,603	$1,626,404	$1,655,781
Cumulative cash flow for new landscape	**<$1,257,785>**	**$339,818**	**$1,966,222**	**$3,622,003**

*Where cash flow denotes the estimated savings or <loss> you could expect after deploying the new SAP landscape.

As shown in Figure 8, after investing $1,257,785 in the new, virtualized SAP landscape, you would break even after only 10 months; your ROI would be 234%. Your savings over the first three years of operation would be more than $2,800,000, which can be invested in value-added projects that support the needs of the business.

Figure 8: ROI break-even time



After only ten months, your investment in the new, virtualized landscape will have paid off. The savings from your IT budget can be invested in value-added projects to increase the profitability and competitiveness of the business.

Using BL685c G6 hosts

Rather than using rack mount HP ProLiant DL785 G6 servers to host VMs in the new landscape, you can use an HP BladeSystem infrastructure featuring HP ProLiant BL685c G6 server blades as hosts. Such an infrastructure provides a range of additional benefits, including:

- Optimized power, cooling, and space requirements
- Support for innovative technologies such as Flex-10

Instead of the 38 physical servers required in the legacy landscape, it now takes only six server blades to support the same workload – four BL685c G6 blades as hosts and two non-virtualized HP ProLiant BL465c G6 server blades to deliver infrastructure services. Since this solution is blade-based, two HP BladeSystem c3000 or c7000 enclosures are also required.

Figure 9 shows the migration from the legacy SAP landscape to the new, virtualized landscape. For simplicity, storage subsystems have been omitted.

Figure 9: Simplified view of the migration from the legacy SAP landscape to a new, virtualized landscape featuring HP ProLiant BL685c G6 server blades

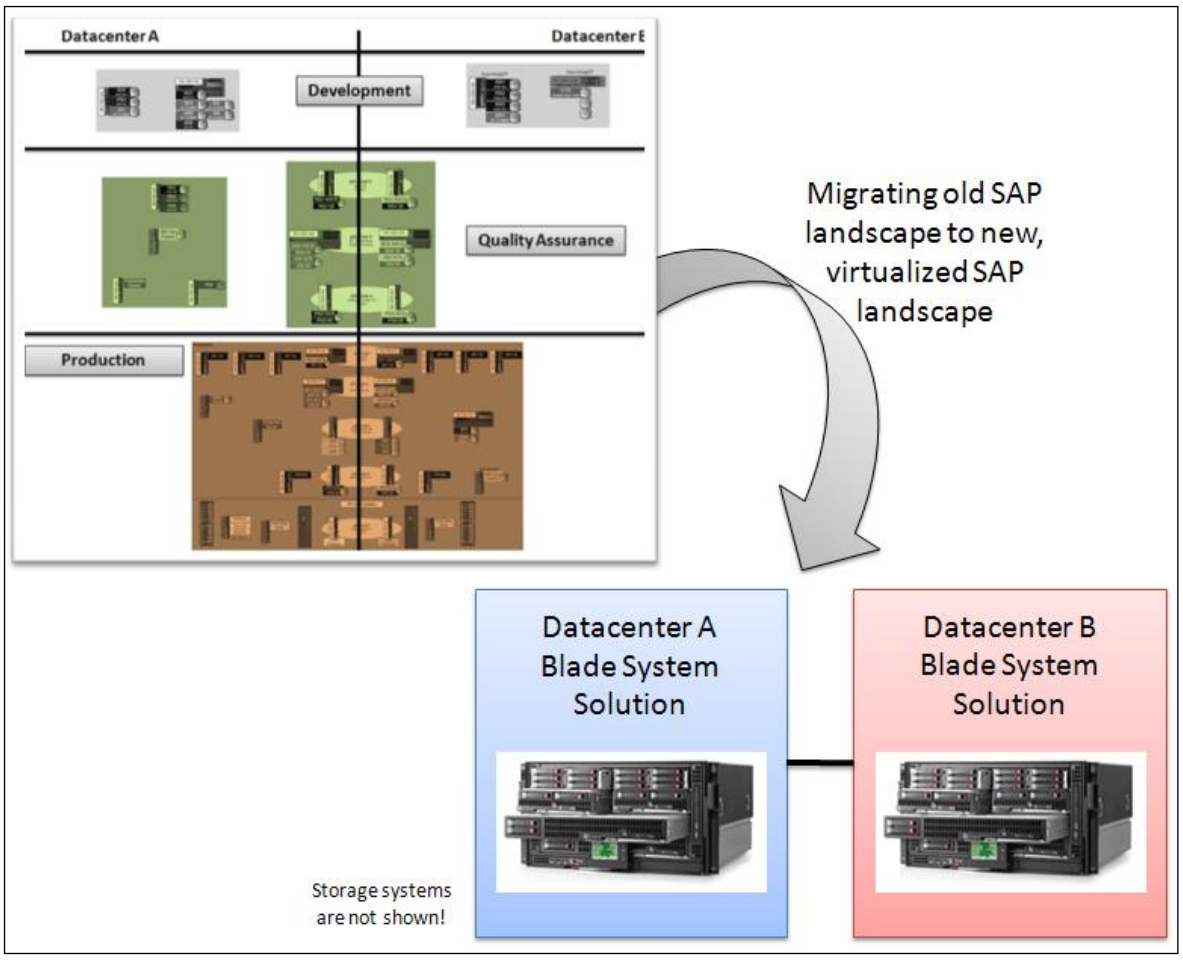


Table 9 provides more information about the new SAP landscape.

Table 9: New SAP landscape featuring BL685c G6 server blades

Item	Role	SAPS*	Quantity	Total list price
HP ProLiant BL685c G6 blade	VMware ESX 4.0 host	15,360	4	$106,800
VMware vSphere Enterprise Plus for one processor (maximum of 12 cores)			16	$70,336
HP ProLiant BL465c G6 blade	Infrastructure services (such as management and backup)		2	$26,682
HP BladeSystem c3000 enclosure	Enclosure and infrastructure components		2	$53,400
			Total	**$257,218**

*Benchmark, SAP ECC 6.0, EHP 4.0

While Table 9 does not include the cost of OS licenses for the VMs, the HP Alinean Enterprise ROI calculator automatically adds Windows license costs to TCO/ROI calculations. Nevertheless, when virtualizing a large number of systems, you should consider obtaining a Windows Server Datacenter license, which provides unlimited support for Windows-based VMs. A Windows Server Datacenter license is less expensive than individual licenses if you virtualize more than 30 systems.

TCO/ROI of the blade-based landscape

Note
Here, the TCO/ROI of a blade-based landscape is compared to that of the DL785 G6 server-based landscape described above, rather than the legacy landscape.

Based on calculations performed by the HP Alinean Enterprise ROI calculator, it is clear that the TCO of a blade-based, virtualized SAP landscape is similar to that of a landscape implemented using rack mount servers.

With only three blades currently installed in each enclosure, the TCO of the BL685c G6 blade-based landscape is only 0.1% higher than that of the implementation using DL785 G6 servers. However, the enclosures offer space for future expansion; thus, if additional hosts were required, the blade-based landscape would deliver additional cost benefits due to its lower infrastructure costs.

Table 10 presents the results of a cumulative three-year TCO comparison between the BL685c G6 blade-based landscape (Solution A) and the DL785 G6 server-based landscape (Solution B). Average, annualized costs are shown.

Note
The HP Alinean Enterprise ROI calculator was updated to reflect current hardware and software costs. The cost of the HP BladeSystem infrastructure (without Flex-10) was added to the hardware costs.

Table 10: TCO comparison

	Solution A	Solution B	Difference (A - B)	Difference (A - B)%
Total	$2,005,009	$2,002,946[17]	$2,563	0.1%

Since there is little difference in TCO between BL685c G6 blade- and DL785 G6 server-based landscapes, ROI has not been calculated for the blade-based solution. It is expected that ROI for the blade-based solution would currently be similar to that for the DL785 G6 server-based solution; however, the blade-based solution becomes even more cost-effective when additional hosts are required.

Since its TCO is approximately the same as that of a new, virtualized SAP landscape implemented using rack mount servers, the blade-based solution is able to deliver the same cost benefits when compared to the legacy landscape. The blade-based solution becomes even more cost-effective when additional hosts are required.

[17] Refer to Table 5

Environmental impact

Actions such as consolidating servers, optimizing utilization, and eliminating under-utilized servers will have a strong, positive environmental impact by reducing the energy needed to power and cool servers and the space needed to house them.

This section attempts to quantify the environmental impact of virtualizing and consolidating the legacy SAP landscape described earlier by comparing the resources (power and cooling) consumed by the legacy landscape and by the new, virtualized landscape featuring rack mount servers.

Resource consumption was calculated as follows:

- **Power** – The power consumed by a particular server was based on the input power rating published in the HP QuickSpecs for that server. Since utilization is relatively low, 50% of the maximum rating was used.

  As power ratings for the legacy server blades have not been published, ratings for equivalent rack mount systems were substituted.

- **Cooling** – The cooling requirements of a server are typically specified in BTU/hour[18]. As a rule of thumb, the power needed to cool a server is assumed to be approximately the same as its input power; thus, Table 11, which shows the total power consumed by the legacy landscape, doubles the input power to obtain total power consumption.

Table 11: Power consumption of servers deployed in the legacy SAP landscape (fully configured at 220 V; running 24 hours a day, 365 days a year)

HP ProLiant server model	Input power (W)	Power for cooling (W)	Number of servers	Total power (kW)	Annual power consumption (MWh)
DL380 G3 (400 W)	200.0	200.0	1	0.40	3.50
DL580 G5 (1412 W)	706.0	706.0	6	8.47	74.21
DL585 G2 (1135 W)	567.5	567.5	2	2.27	19.89
BL20p G2 (400 W*)	200.0	200.0	6	2.40	21.02
BL25p G1 (400 W*)	200.0	200.0	8	3.20	28.03
BL25p G2 (400 W*)	200.0	200.0	2	0.80	7.01
BL45p G1 (1135 W*)	567.5	567.5	11	12.49	109.37
BL45p G2 (1135 W*)	567.5	567.5	2	2.27	19.89
Total power consumption, including cooling				**32.30 (kW)**	**282.92 (MWh/year)**

*Estimated; based on a comparable rack mount server

After the SAP landscape has been virtualized, there are only four rack mount servers to power and cool. However, since resource utilization is higher in the new landscape, 80% of the server's maximum input power rating is now used when overall power consumption (shown in Table 12) is calculated.

[18] British Thermal Unit (BTU) = Volts x Amps x 3.41, source: http://h10025.www1.hp.com/ewfrf/wc/document?docname=c00211069&tmp_track_link=ot_faqs/top_issues/en_us/c00211069/loc:1&lc=en&dlc=en&cc=us&product=359806

Table 12: Power consumption of servers deployed in the virtualized landscape

HP ProLiant server model	Input power (W)	Power for cooling (W)	Number of servers	Total power (kW)	Annual power consumption (MWh)
DL 385 G6 (460 W)	368	368	2	1.47	12.89
DL 785 G6 (2800 W)	2240	2240	2	8.96	78.49
Total power consumption, including cooling				**10.43 kW**	**91.38 MWh/year**

When running in the legacy landscape, the SAP systems require approximately 283 MWh per year, nearly three times more than the new, virtualized landscape with rack mount servers, which would need less than 92 MWh per year. Thus, approximately 68% of annual power costs would be saved by virtualizing the SAP landscape.

Thus, the virtualized landscape would save you approximately $13,500[19] (in addition to savings predicted by the HP Alinean Enterprise ROI calculator) in annual power costs; furthermore, based on a worldwide average of 0.51 kg of CO^2 emissions per kWh of electricity consumed[20], approximately 98 tons of CO^2 emissions would also be saved.

Note
Power calculations assumed 50% utilization in the legacy landscape and 80% in the new, virtualized landscape.

In addition to saving more than $2,800,000 over the first three years and breaking even on your investment after only ten months, you would also reduce your annual CO^2 emissions by almost 100 tons.

[19] US average retail price of electricity September 2009 6.99 cents per kW/hour, source: http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_a.html; thus, annual savings are 282.92 – 91.38 = 191.54 MWh; 191,540 KWh x 6.99 cents = $13,388.65

[20] http://www.hp.com/hpinfo/globalcitizenship/environment/products/lowcarbon-solutions.html, footnote 3; thus, (283 MWh – 91 MWh) x 0.51 kg/CO^2 per kWh represents 97.92 tons of CO^2.

Report card

Table 13 shows how well this new, virtualized SAP landscape would meet its defined objectives.

Important
The virtualized SAP landscape proposed in this white paper is based on resource utilization in a particular legacy landscape and on estimated server performance capacity. Thus, costs are also estimates and are only used to demonstrate possible TCO and ROI improvements with a virtualized landscape.
Results for different landscapes may differ.

Table 13: Report card for the virtualized landscape

Objective	Result	
Reduce the number of physical servers required to run the workload	The number of physical servers would be reduced by as much as 90%.	☺
Better utilize the physical servers	Projected server utilization is 107%[21] – not enough to overload the hosts since some production systems have low utilization rates.	☺
Increase the flexibility of the landscape so that you can respond more quickly to changing business needs	vSphere provides a range of capabilities (such as VM migration, dynamic resource assignment, and high availability) than can enhance the agility of a modern data center.	☺
Reduce software licensing costs	Lowering the number of systems requiring operating system licenses from 38 to 30 would reduce Windows licensing costs by 21%; however, you now require licenses for VMware products. Consolidating SAP instances or eliminating old SAP systems would further reduce licensing costs.	😐
Reduce servicing costs	Lowering the number of physical servers by 90% would significantly reduce service costs.	☺
Reduce the amount of labor required to manage physical servers and VMs	Virtualizing the SAP landscape would reduce management costs through advanced management capabilities for deployment and administration; according to VMware, operational costs may be reduced by 25%[22].	☺
Reduce the amount of labor required to manage the entire SAP landscape	Lowering the number of physical servers would also reduce requirements for physical networks and storage, and power and cooling systems.	☺
Reduce power and cooling requirements	Power and cooling costs would be reduced by almost 70% in the new landscape.	☺

Continued

[21] Based on the sizing performed by HP
[22] Cp. (VMware, Inc, 2009b), VMware: "vmworld 2009, welcome and opening keynote VMworld2009_General_Session_Maritz.pdf", page 13

Table 13: Report card for the virtualized landscape (continued)

Objective	Result	
Make space available in the data center	The new landscape would free up space by significantly lowering the number of physical servers and infrastructure components deployed.	☺
Re-use up-to-date infrastructure components	Existing storage and network components would be re-used in the new landscape; no new storage hardware would be required.	☺

Summary

Virtualization has come a long way since the 1960s, when scientists and engineers first pioneered virtualization solutions like time-sharing that allowed multiple users to work concurrently on mainframe systems.

Deploying even the most business-critical of SAP systems on VMs is now possible due to rich virtualization solutions from HP (such as powerful HP ProLiant servers featuring hardware acceleration for virtualization) with the support of vendors like SAP, VMware, Microsoft, and Oracle®.

Outstanding ROI – 234% in the real-world example outlined in this white paper – means that your initial investment in a virtualized SAP landscape can quickly pay off. Moreover, since TCO is much lower than in a non-virtualized, legacy landscape, virtualization can free up IT budgets that had previously been overloaded by high maintenance and operational costs.

Not only are its business values compelling, virtualizing an SAP landscape can also lower your impact on the environment. Even a smaller implementation – such as that described in this white paper – can reduce overall requirements for space, power, and cooling.

Virtualization helps you regain control of your sprawling SAP systems and, in conjunction with HP technologies like Dynamic Power Capping, can be used to create the foundation for a fully dynamic, automated, flexible data center capable of supporting your current and future business needs.

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Appendix A – Legacy servers

Table 14 outlines the configurations and workloads of physical servers in the legacy SAP landscape.

Table 14: Legacy landscape

Server name	**SAP application**	**Database**	**HP ProLiant server model**	**CPU**	**CPU utilization** (%) [1]	**Memory** (MB)	**Memory bottleneck probability** (%) [2]	**Available/ used storage** (GB)	**Disk I/O utilization** (%)
				Development systems (4)					
Server 1	1 x SAP Content Server 6.40	MaxDB 7.5	DL380 G3	Xeon (2.4 GHz), 2 cores	6.6	3,887	3.4	913/ 331	18.0
Server 2	1 x SAP BI 7.0 3 x SAP ECC 6.0	SQL Server 2005	BL45p G2	Opteron Processor 8216 (2.4 GHz), 8 cores	35.3	65,534	7.8	11,637/ 8872	64.1
Server 3	1 x SAP ECC 6.0 1 x SAP EP 7.0 1 x SAP BI	SQL Server 2005	BL25p G1	Opteron Processor 275 (2.2 GHz), 4 cores	13.5	16,215	13.9	2,414/ 1,912	41.3
Server 4	1 x SAP ECC 6.0 2 x SAP BI 1 x SAP XI	SQL Server 2005	DL585 G2	Opteron Processor 8222 (3.0 GHz), 8 cores	9.1	65,534	21.2	7,806/ 6,862	29.8

Continued

[1] Utilization of the server's total processing capacity,
[2] Memory bottleneck probability is an indicator based on the following metrics: the amount of physical memory used, the number of page-out requests, and page request rate. On a system with a typical workload, this probability should be below 75%.

Table 14: Legacy landscape (continued)

Server name	**SAP application**	**Database**	**HP ProLiant server model**	**CPU**	**CPU utilization** (%) [1]	**Memory** (MB)	**Memory bottleneck probability** (%) [2]	**Available/ used storage** (GB)	**Disk I/O utilization** (%)
QA systems (9)									
Server 5	1 x SAP ECC 6.0 (failover cluster node)	SQL Server 2005	BL45p G1	Opteron Processor 875 (2.2 GHz), 4 cores	7.2	20,311	9.5	3,217/ 2,898	18.5
Server 6	1 x EP 7.0 (failover cluster node)	SQL Server 2005	BL25p G1	Opteron Processor 270 (2.0 GHz), 2 cores	17.0	3,927	7.7	248/ 92	16.7
Server 7	1 x BI 7.0 (failover cluster node)	SQL Server 2005	DL580 G5	Xeon Processor X7350 (2.93 GHz), 8 cores	10.1	65,533	4.2	488/ 331	5.0
Server 8	1 x SAP ECC 6.0 (failover cluster node)	SQL Server 2005	BL45p G1	Opteron Processor 875(2.2 GHz), 4 cores	4.1	20,311	7.4	344/ 108	12.5
Server 9	1 x EP 7.0 (failover cluster node)	SQL Server 2005	BL25p G1	Opteron Processor 275 (2.2 GHz) 2 cores	5.4	3,927	3.4	248/ 153	7.9
Server 10	1 x BI 7.0 (failover cluster node)	SQL Server 2005	DL580 G5	Xeon Processor X7350 (2.93 GHz), 8 cores	1.6	65,533	2.3	5214/ 4546	0.6
Server 11	1 x BSI Tax Factory	SQL Server 2005	BL20p G2	Xeon Processor (3.06GHz), 2 cores	4.7	3,071	1.6	34/ 19	5.4
Server 12	1 x Conversion server		BL25p G1	Opteron 275(2.2 GHz), 4 cores	5.6	8,023	0.4	137/ 39	7.3

Continued

Table 14: Legacy landscape (continued)

Server name	**SAP application**	**Database**	**HP ProLiant server model**	**CPU**	**CPU utilization** (%) [1]	**Memory** (MB)	**Memory bottleneck probability** (%) [2]	**Available/ used storage** (GB)	**Disk I/O utilization** (%)
Server 13	1 x SAP R/3 6.40		BL25p G1	Opteron Processor 275(2.2 GHz), 4 cores	15.2	26,455	18.7	5,657/ 4,525	44.1
Server 14	1 x PD5	SQL Server 2005	BL25p G1	Opteron Processor 275(2.2 GHz), 4 cores	4.8	16,215	1.7	137/ 62	9.0
				Development systems (25)					
Server 15	1 x NWA SLD 6.40		BL20p G2	Xeon Processor (3.06GHz), 2 cores	25.2	3,839	0.9	`	27.2
Server 16	1 x conversion server	SQL Server 2005	BL20p G2	Xeon Processor (3.06GHz) 2 core)	15.9	7,935	40.0	294/ 251	28.6
Server 17	1 x SAP Content Server 6.40 (failover cluster node)	MaxDB 7.5	BL25p G1	Opteron Processor 275 (2.2 GHz), 4 cores	5.3	8,023	0.7	3,040/ 2,510	27.3
Server 18	1 x SAP EP 7.0 (failover cluster node)	SQL Server 2005	BL45p G1	Opteron Processor 875 (2.2 GHz) 2 cores	7.9	8,023	0.6	208/ 74	7.7
Server 19	1 x HP Data Protector (failover cluster node)		BL25p G2	Opteron Processor 2218 (2.6 GHz) 4 cores	4.8	2,046	3.4	262/ 142	0.9

Continued

Table 14: Legacy landscape (continued)

Server name	**SAP application**	**Database**	**HP ProLiant server model**	**CPU**	**CPU utilization** (%) [1]	**Memory** (MB)	**Memory bottleneck probability** (%) [2]	**Available/ used storage** (GB)	**Disk I/O utilization** (%)
Server 20	1 x SAP BI 7.0 (failover cluster node)	SQL Server 2005	DL580 G5	Xeon Processor X7350 (2.93 GHz), 8 cores	10.1	65,533	4.2	137/ 81	5.0
Server 21	1 x SAP ECC 6.0 (failover cluster node)	SQL Server 2005	DL580 G5	Xeon Processor X7350 (2.93 GHz), 8 cores	1.7	131,069	4.8	274/ 96	0.2
Server 22	1 x BSI Tax Factory	SQL Server 2005	BL20p G2	Xeon Processor (3.06 GHz) 2 cores)	4.6	3,903	1.3	34/ 27	8.5
Server 23	1 x SAP DI ECC 6.40		BL45p G1	Opteron Processor 875 (2.2 GHz), 4 cores	11.1	48,983	5.1	137/ 106	11.4
Server 24	1 x SAP DI ECC 6.40		BL45p G2	Opteron Processor 8216 (2.4 GHz) 8 cores	13.4	4,9150	4.5	137/ 110	2.5
Server 25	1 x SAP DI ECC 6.40		BL45p G1	Opteron Processor 880 (2.4 GHz) 8 cores	10.5	65,367	4.0	137/ 89	15.4
Server 26	1 x SAP DI EP 7.0		BL45p G1	Opteron Processor 875 (2.2 GHz) 4 cores	3.1	16,215	0.4	137/ 58	3.8
Server 27	1 x SAP PI 7.0 1 x SAP SolMan 7.0	SQL Server 2005	DL585 G2	Opteron 8222 (3.0 GHz), 8 cores	4.0	65,534	40.0	428/ 222	16.0

Continued

Table 14: Legacy landscape (continued)

Server name	**SAP application**	**Database**	**HP ProLiant server model**	**CPU**	**CPU utilization** (%) [1]	**Memory** (MB)	**Memory bottleneck probability** (%) [2]	**Available/ used storage** (GB)	**Disk I/O utilization** (%)
Server 28	1 x SAP Content Server 6.40 (failover cluster node)	MaxDB 7.5	BL25p G1	Opteron Processor 275 (2.2 GHz), 4 cores	1.5	8,023	0.4	137/ 56	5.1
Server 29	1 x SAP EP 7.0 (failover cluster node)	SQL Server 2005	BL45p G1	Opteron Processor 875 (2.2 GHz), 2 cores	14.8	8,023	5.4	208/ 64	11.5
Server 30	1 x HP Data Protector (failover cluster node)		BL25p G2	Opteron Processor 2218 (2.6 GHz) 4 cores	4.6	2,046	1.2	137/ 21	4.1
Server 31	1 x SAP BI 7.0 (failover cluster node)	SQL Server 2005	DL580 G5	Xeon Processor X7350 (2.93 GHz), 8 cores	27.9	65,533	6.9	5,215/ 4,268	24.8
Server 32	1 x SAP ECC 6.0 (failover cluster node)	SQL Server 2005	DL580 G5	Xeon Processor X7350 (2.93 GHz) 8 cores	24.8	131,069	11.7	4,054/ 3,127	48.3
Server 33	1 x SAP DI ECC 6.40		BL45p G1	Opteron Processor 875 (2.2 GHz), 8 cores	10.3	48,983	1.6	137/ 104	5.4
Server 34	1 x SAP DI ECC 6.40		BL45p G1	Opteron Processor 875 (2.2 GHz), 8 cores	12.9	48,983	5.7	137/ 112	10.1

Continued

Table 14: Legacy landscape (continued)

Server name	**SAP application**	**Database**	**HP ProLiant server model**	**CPU**	**CPU utilization** (%) [1]	**Memory** (MB)	**Memory bottleneck probability** (%) [2]	**Available/ used storage** (GB)	**Disk I/O utilization** (%)
Server 35	1 x SAP DI ECC 6.40		BL45p G1	Opteron Processor 880 (2.4 GHz), 8 cores	8.5	65,367	2.4	137/ 112	12.9
Server 36	1 x SAP DI EP 7.0		BL45p G1	Opteron Processor 875 (2.2 GHz), 4 cores	3.2	16,215	0.1	137/ 57	10.1
Server 37	1 x HP EVA Command View		BL20p G2	Xeon Processor (3.20GHz), 2 cores	0.8	5,887	0.1	34/ 16	4.3
Server 38	1 x Cluster arbitrator		BL20p G2	Xeon Processor (3.20GHz), 2 cores	25.0	3,011	0.3	68/ 16	8.6
Summary [3]									
Total number of servers				**Total number of cores**	**Average CPU utilization** (%)	**Total memory/ average** (GB)	**Average memory bottleneck probability** (%)	**Total storage available/ used (**GB**)**	**Average disk I/O utilization** (%)
38 servers				190	10.32	1,234/ 32	6.55	54,214/ 42,544 [4]	15.26

[3] Average figures were obtained by summing the cells in a particular column and dividing by 38 (the number of physical servers).
[4] On average, servers are configured with 1,427 GB of available storage. Overall, 78% of available storage is being used.

Appendix B – Servers in the new landscape

This appendix outlines servers suggested by HP for the new SAP landscape. Options based on rack mount servers and an HP BladeSystem infrastructure are presented.

Note
All pricing is estimated and is only used to demonstrate TCO and ROI enhancements possible with a virtualized SAP landscape.

Rack mount servers

Tables 15 and 16 outline rack mount servers recommended for the new SAP landscape.

Table 15: Detailed configuration of each rack mount host (total of two) in the new SAP landscape

Component	Description
	HP ProLiant DL785 G6 server
	
Processor	8 x Six-Core AMD Opteron Processor Model 8439 SE (2.8 GHz/6 MB L3 cache/105 W)
Memory	256 GB (HP 128GB REG PC2-6400 32x4 LP Dual Rank Memory)
Network controller	2 x 1GbE NC371i Multifunction 2 Ports (onboard) 2 x 1GbE NC373T PCI-E Multifunction Gigabit Server Adapter 2 x HP NC522SFP Dual Port 10GbE Gigabit Server Adapter 2 x HP NC364T PCI-E Quad Port Gigabit Server Adapter
Hard disk drives	4 x HP 146GB 3G Hot Plug 2.5 SAS Dual Port 15,000 rpm Enterprise Hard Drive
FC controller	2 x HP StorageWorks 82Q 8Gb Dual Port PCI-e Fibre Channel Host Bus Adapter
Power supply	3 x HP 1200W CS HE Power Supply
Infrastructure management	HP Integrated Lights-Out (iLO) Standard, HP Systems Insight Manager (HP SIM)
Warranty	3 years parts/labor/onsite service (3/3/3) standard warranty
List price[23]	**Approximately $67,000 each**
	VMware software
	VMware vSphere Enterprise Plus Acceleration Kit for 8 processors
List price[24]	**Approximately $32,000 each**

[23] Cp. (HP, 2009h), HP ProLiant DL785 G6 Server series – Models, access date January 2010
[24] Cp. (VMware, Inc., 2009f), VMware store, VMware vSphere Enterprise Plus Acceleration Kit (for 8 Processors) , access date January 2010

Table 16: Detailed configuration of each rack mount infrastructure server (total of two) in the new SAP landscape

Component	Description
	HP ProLiant DL385 G6 server
	
Processor	2 x Six-Core AMD Opteron Processor Model 2431 SE (2.4 GHz/6 MB L3 cache/75 W)
Memory	48 GB (HP REG PC2-6400 12x4 LP Memory)
Network controller	2 x HP NC382i Dual Port Multifunction Gigabit Server Adapters, 2 Ports (onboard) 1 x HP NC364T PCI Express Quad Port Gigabit Server Adapter 1 x HP Dual Port 10GbE Riser Card
Hard disk drives	6 x HP 300GB 6G Hot Plug 3.5 SAS 15,000rpm Dual Port Hard Drive
FC controller	1 x HP StorageWorks FC2242 Dual Channel 4Gb PCI-e HBA
Power supply	2 x HP 750W CS HE Hot-Plug Power Supply
Infrastructure management	HP Integrated Lights-Out (iLO) Standard, HP Systems Insight Manager (HP SIM)
Warranty	3 years parts/labor/onsite service (3/3/3) standard warranty
List price[25]	**Approximately $13,200 each**

[25] Cp. (HP, 2009t), HP ProLiant DL386 G6, access date January 2010

HP BladeSystem infrastructure

Tables 17 – 19 outline server blades and associated enclosures recommended for the new SAP landscape.

Table 17: Detailed configuration of each server blade host (total of four) in the new SAP landscape

Component	Description
HP ProLiant BL685c G6 server blade	
	
Processor	4 x Six-Core AMD Opteron Processor Model 8435 SE (2.6 GHz/6 MB L3 cache/75 W)
Memory	HP 128GB REG PC2-6400 32x4GB Dual Rank Memory
Network controller	2 x Embedded 1Gb/10Gb Multifunction Network Adapter 1 x HP BLc QLogic iSCSI Dual Port Adapter w/VC Kit 1 x HP BLc NC542m 10GbE KR Dual Port Adapter
Hard disk drives	2 x HP 146GB 6G Hot Plug 2.5 SAS Dual Port 15,000 rpm Enterprise Hard Drive
FC controller	1 x HP BLC Emulex Dual LPe1205 8Gb, Fibre Channel Host Bus Adapter
Infrastructure management	iLO Standard, HP SIM
Warranty	3 years parts/labor/onsite service (3/3/3) standard warranty
List price[26]	**Approximately $26,700 each**
	VMware software
	4 x VMware vSphere 4 Enterprise Plus for 1 processor (maximum 12 cores per processor) and Platinum (24x7) 1 Year Support
List price[27]	**Approximately $17,476 each**

[26] Cp. (HP, 2009u), HP HP ProLiant BL685c Generation 6 (G6) Server Blade, access date January 2010
[27] Cp. (VMware, Inc, 2009h), VMware store, VMware vSphere Editions, access date January 2010

Table 18: Detailed configuration of each server blade used as an infrastructure server (total of two) in the new SAP landscape

Component	Description
HP ProLiant BL465c G6 server blade	
	
Form factor	Half-height (up to eight supported in an HP BladeSystem c3000 enclosure)
Processor	2 x Six-Core AMD Opteron Processor Model 2435 (2.6 GHz/6 MB L3 cache/75 W)
Memory	HP 32GB Reg PC2-5300 4x8GB Memory
Network controller	1 x Dual NC370i Multi Function Network Adapter 1 x HP NC364m Quad Port 1GbE BL-c Adapter
Hard disk drives	2 x HP 500GB 6G Hot Plug 2.5 SAS 7,200rpm MDL Hard Drive
FC controller	1 x QLogic QMH2462 4Gb FC HBA for HP c-Class Blade System
Infrastructure management	iLO 2, HP SIM
Warranty	3 years parts/labor/onsite service (3/3/3) standard warranty
List price[28]	**Approximately $13,341 each**

HP BladeSystem enclosure

Two HP BladeSystem enclosures – one at each site – are required to house the server blades used to host VMs and act as infrastructure servers. HP suggests deploying c3000 enclosures (as shown in Table 19) that include the following components:

- Redundant power supplies and fans
- Ethernet and FC blade switches

A c3000 enclosure can support a range of blade configurations, such as the following:

- Up to eight half-height server blades (such as the BL465c G6) or
- Up to four full-height server blades (such as the BL685c G6)

While an enclosure can provide room for growth, an HP BladeSystem deployment may involve a higher initial investment than a rack mount solution. However, these initial costs would pay off as soon as the landscape requires additional hosts.

Alternatively, a larger c7000 enclosure can be used.

[28] Cp. (HP, 2009k), HP ProLiant BL465 G6, access date January 2010

Table 19: Detailed configuration of each enclosure (total of two) used to house server blades in the new SAP landscape

Component	Description
HP BladeSystem c3000 enclosure	
	
Power module	HP Single Phase Power Module
Power supply	6 x HP c3000 Enclosure AC Power Supply
Fan	6 x HP BladeSystem Single Active Cool 100 Fan
Management	2 x HP BLc3000 Dual DDR2 Onboard Administration Module
Network	2 x HP BLc GbE2c Ethernet Layer 2/3 Switch for HP c-Class BladeSystem
FC SAN	2 x HP 8/12c SAN Switch c-Class BladeSystem
List price[29]	**Approximately $23,670 each**

[29] Cp. (HP, 2009l), HP BladeSystem c-Class c3000 Enclosure, access date January 2010

Appendix C – IT operations

The technical infrastructure of a SAP landscape requires with a high initial investment and significant, ongoing operational costs that soon exceed the initial investment. These operational costs increase over time as more and more systems are added to the landscape.

On the iSixSigma website, operational costs are specified[30] as follows:

> *"The value of the item purchased will diminish as it is used up e.g. consultancy. Sometimes operational costs are a variable cost (paper, consultancy assistance) and sometimes fixed (salaries). For practical purposes in IT Accounting, operational costs can be considered as those charged to a single financial year, with no depreciation element."*

Administrator roles

The following roles are typically involved in the management of an SAP landscape:

- Network administrator
- Storage administrator
- Server operator
  - Hardware service technician
  - Operating system administrator
- Database administrator
- SAP Basis administrator
- SAP module administrator/business manager

Each of these roles requires a special skill set and experience so that the SAP landscape can be managed as efficiently as possible. Depending on the education and experience of the available IT staff, these roles may be performed by a single individual or distributed between many different individuals.

When roles and responsibilities are combined, automation and management solutions such as the HP Insight Control suite[31] can be used to help system administrators maintain control over a growing SAP landscape.

Management tasks

The following management tasks must be performed in a typical SAP landscape:

- Server and application deployment
- Ongoing system health checks of the server hardware, operating system, and SAP application
- Server hardware maintenance (such as the installation of new firmware or the replacement of a defective hard disk drive)
- Operating system maintenance, update, and configuration
- SAP system patching and configuration
- System backup tasks (operating system, database, and SAP application)
- System re-configuration to adapt to changing business needs

[30] Cp. (Jones, 2005a), iSixSigma webpage: http://www.isixsigma.com/dictionary/Operational_Cost-817.htm
[31] Cp. (HP, 2009b) , HP Insight Software, website

For convenience, the above management tasks can be summarized as “IT operations,” a line-item used when calculating the TCO of an SAP landscape.

Changing business needs often require IT systems to be updated or replaced. Adding more and more physical servers can, over time, dramatically increase your operational costs.

Non-standard landscapes and system configurations would further increase complexity and cost.

Appendix D – Advanced VMware vSphere functionality

This appendix provides an overview of advanced features offered by the VMware vSphere virtualization solution, such as VMotion, Distributed Resource Scheduler (DRS), High Availability (HA), and Fault Tolerance (FT) can.[32]

VMotion

A basic technology built into vSphere, VMotion[33] supports the migration of a running SAP VM from one physical host to another without downtime. Indeed, VMware makes the following guarantees for such live migrations:

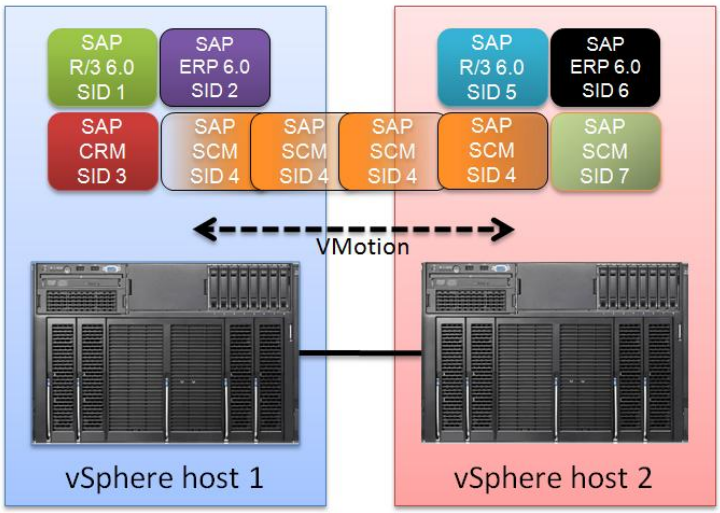
- Zero downtime for the SAP VM
- Continuous service availability
- Complete transaction integrity

VMware notes the following benefits for VMotion:

- Improved service availability and maintainability – You can perform maintenance tasks on the hosts without disrupting running SAP VMs.
- Enhanced resource utilization – Since you can migrate VMs to hosts with free resources, you can support more VMs in a particular resource pool.

Figure 10 illustrates the live migration of a VM.

Figure 10: Live migration of VM (SAP SCM SID 4) from vSphere Host 1 to vSphere Host 2



VMotion is based on the following components:

- VMotion uses the underlying VMware shared cluster file system (VMFS), whereby the state of each VM is stored and encapsulated within a set of files maintained on shared storage (such as an iSCSI or FC SAN.

[32] Cp. (VMware, Inc., 2009k) , VMware document: „Introduction to VMware vSphere"
[33] Cp. (VMware, Inc., 2009r), VMware data sheet: "VMware VMotion"

- The high-speed VMkernel network allows the VM's active memory and execution states to be transferred from one host to another.

  Unlike some other virtualization solutions, VMware keeps track of possible changes to the contents of a VM and stores any changes in a transaction bitmap. After the VM's memory and execution state have been migrated, VMotion suspends the operation of the VM until the contents of the bitmap are transferred to the new host. VMware claims that this "*entire process takes less than two seconds on a Gigabit Ethernet network.*" [34]
- VM network functionality maintains the migrating VM's network identity (such as its MAC address) by pinging the physical network router to which the VMware hosts are connected to ensure the router is aware of the move.

Since the migration of a VM via VMotion preserves the precise execution state, the network identity, and the active network connections, the result is zero downtime with no disruption to users.

Storage VMotion

In addition to live migration, during which a VM is migrated from one host to another, VMware also provides Storage VMotion technology[35], which can migrate the virtual disk files of a running VM to a new storage array "*with zero downtime, continuous service availability and complete transaction integrity.*"

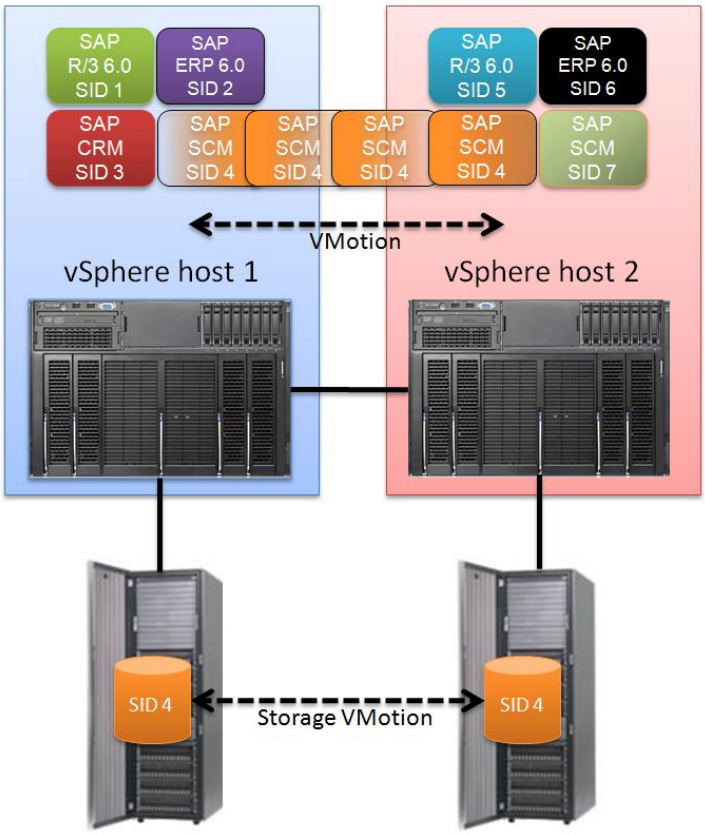
VMware notes the following benefits for Storage VMotion:

- Easy migrations and upgrades
- Dynamic I/O performance optimization for storage
- Efficient storage management and utilization

Figure 11 illustrates the live migration of VM storage. In this example, Storage VMotion has been combined with VMotion.

[34] (VMware, Inc., 2009r), VMware data sheet: "VMware VMotion"
[35] (Vmware, Inc., 2009t), VMware data sheet: "VMware Storage VMotion"

Figure 11: Live migration of the storage associated with a VM (SAP SCM SID 4) from one storage array to another



The Storage VMotion process is carried out as follows:

1. The VM's home directory (containing metadata such as configuration, swap, and log files) is migrated to the new storage location.
2. After the home directory has been migrated, Storage VMotion next copies the contents of the VM's disk files to the new storage location using **changed block tracking**, which maintains data integrity during the migration.
3. Now, any data blocks that changed during the copy phase (1. and 2. above) are replicated to the new storage location. Replication is repeated until there are no more changes to the original storage.

☞ Storage VMotion supports transparent storage migration and management, making it easy to change disk arrays.

DRS

DRS makes it possible to automate the distribution of VMs on a vSphere cluster based on host workload levels and the availability of resources.[36] Pre-defined rules, used in conjunction with the prioritization of VMs based on the needs of the business, enable this process.

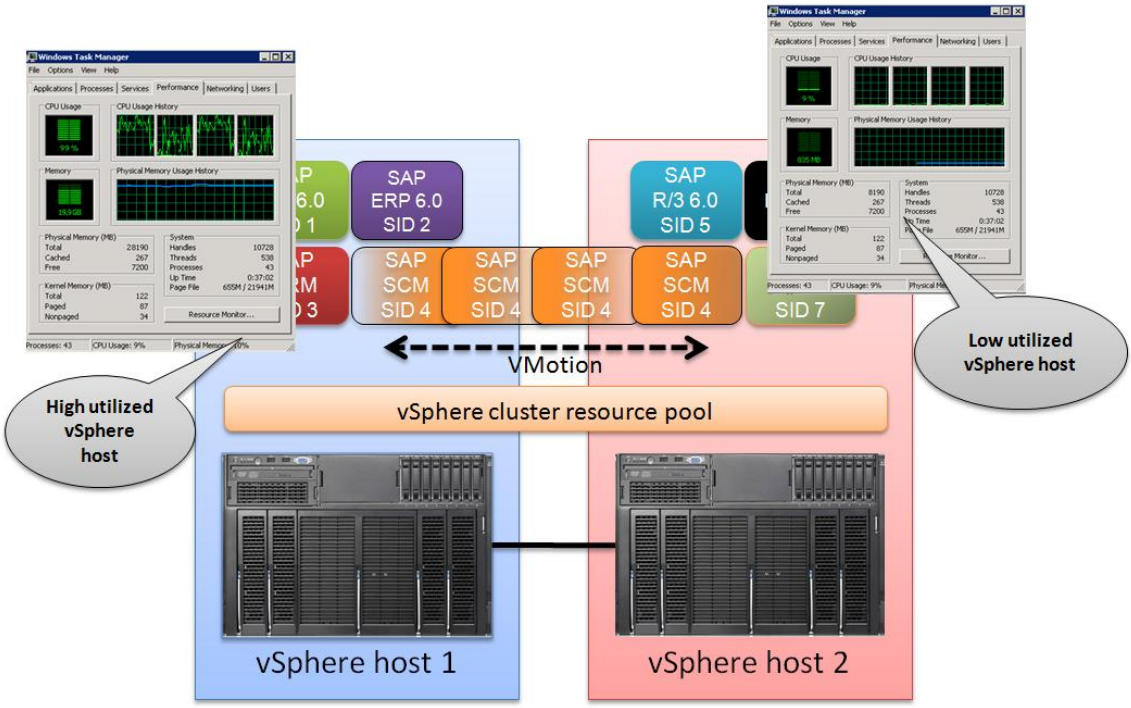
In addition to load distribution and the optimization of resource allocation, DRS can actively manage the power consumption of servers – using VMware Distributed Power Management (DPM) – to minimize the power consumption of a DRS-enabled vSphere cluster.

VMware notes the following benefits for DRS:

- VM prioritization drives the automated, optimal distribution and allocation of resources. For example, SAP production systems can be given the highest priority, ensuring that they receive the largest share of the pooled resources.
- DRS can increase host utilization levels by better managing pooled resources.
- Since it is possible to reserve resources, DRS can react in real-time to changes in demand.
- With DPM, power consumption and costs may be reduced by as much as 20%.

Figure 12 shows how DRS can utilize VMotion to re-distribute resources.

Figure 12: DRS-initiated migration of a VM (SAP SCM SID 4) from highly-utilized vSphere Host 1 to less-utilized vSphere Host 2



The DRS process is carried out as follows:

1. DRS builds resource pools utilizing the resources of specified vSphere hosts.
2. You define the rules and policies that control how DRS assigns these resources, setting expectations for each VM.

[36] (VMware, Inc., 2009u), VMware data sheet: "VMware Distributed Resource Scheduler (DRS)"

3. When the utilization of a VM increases, DRS checks the priority-level assigned to this VM. If permissible, DRS automatically assigns CPU and/or memory resources to the VM, either by reallocating resources available on the host or migrating the VM to another, less- utilized host. Migrations are handled transparently by VMotion.

DRS supports the flexible, hierarchical organization of resource pools that are utilized based on the needs of the business. Resource reservations and VM prioritization allow you to dedicate resources to particular applications; the pooling of resources promotes efficiency[37].

HA

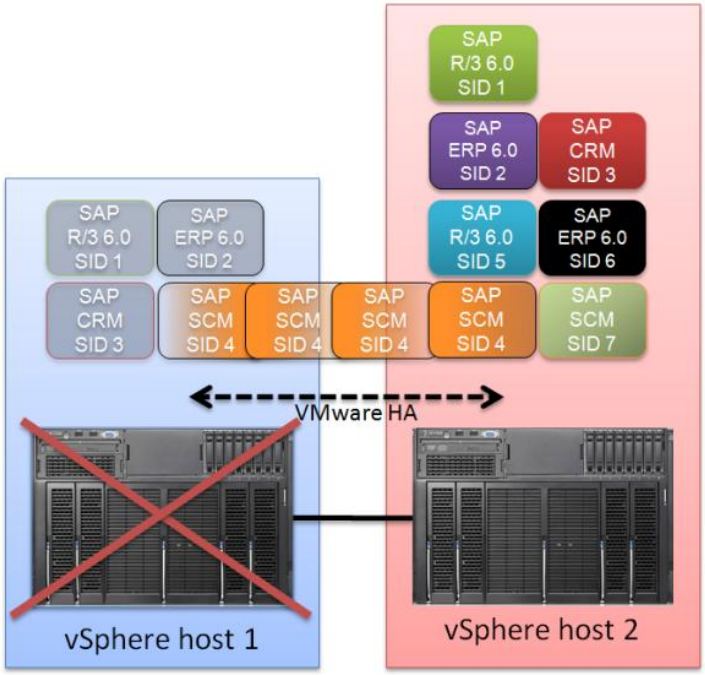
VMware HA is an integral component of the vSphere solution[38], providing an easy, cost-effective mechanism for protecting SAP applications running in VMs. With HA, physical host failures are automatically detected; if appropriately configured, affected VMs are automatically restarted on another host.

The benefits of HA include:

- Less unplanned downtime and service disruption
- No need for dedicated standby hardware and associated software
- Consistent high availability across the virtualized environment

Figure 13 shows how HA can automatically migrate VMs after a host failure.

Figure 13: VMs (SAP SCM SID 1 – 4) migrated to vSphere Host 2 following the failure of vSphere Host 1



[37] (VMware, Inc., 2009u), VMware data sheet: "VMware Distributed Resource Scheduler (DRS)", page 2
[38] (VMware, Inc., 2009v), VMware data sheet: "VMware High Availability"

The HA process for responding to a host failure is carried out as follows:

1. An agent installed on each vSphere cluster host monitors the server's heartbeat and detects physical server and operating system failures. The loss of the heartbeat automatically starts the migration of local VMs to another host.
2. HA uses VMFS in conjunction with iSCSI or FC SAN storage to give surviving cluster nodes access to disk files associated with VMs from the failed node. HA works in conjunction with DRS to place qualified VMs on surviving nodes with sufficient resources.
3. The VMware Tools package installed on each VM monitors the VM's heartbeat. If the heartbeat is lost for a specified length of time, the VM is restarted on another host.

The HA feature ensures that there are always sufficient pooled resources in a vSphere cluster to support a VM migration and restart.

HA is able to detect host and guest hardware and OS failures. In the event of a failure, affected VMs are restarted on another host.

FT

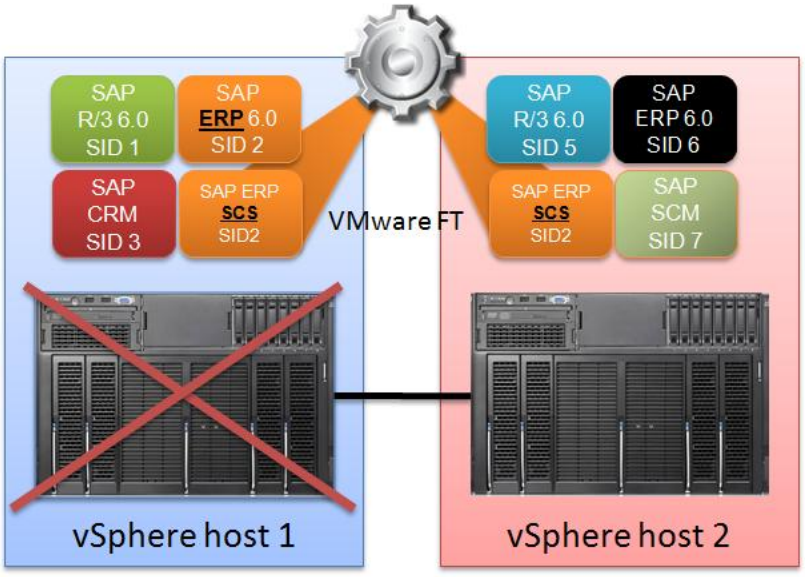
FT provides "*zero-data-loss continuous availability for any application, without the cost or complexity of traditional solutions.*"[39]

VMware has developed FT's **vLockstep** technology to help you avoid application downtime due to hardware failures by reducing the complexity and cost normally associated with fault-tolerant solutions.

Since its capabilities are limited to a single CPU, FT cannot protect a full SAP system. Thus, in the example shown in Figure 14, FT has been used to protect the SAP central services instance that, with the database, is one of the single-points-of-failure (SPOFs) in an SAP system. HA in conjunction with database log shipping can be used to protect application server and database instances.

[39] (VMware, Inc., 2009o), VMware data sheet: "VMware Fault Tolerance"

Figure 14: FT used to protect a SPOF in an SAP system



The FT process is carried out as follows:

1. FT creates a live shadow instance of the primary VM, which runs on a different physical host in the vSphere cluster.
2. VMware vLockstep technology synchronizes the two instances by logging the primary VM's non-deterministic event execution and transmitting the logs over a Gigabit Ethernet network to be replayed by the secondary VM.

   Lock-stepped VMs have always the same status since they receive exactly the same set of inputs at any particular time. These VMs appear as a single VM; they share a common disk, IP address, and a single MAC address. However, during operation, only the primary VM can perform writes.
3. A heartbeat is sent from one VM to the other at millisecond intervals. If the heartbeat from one VM is lost, the other VM takes over immediately, with no loss of data or state.

Note
A dedicated Gigabit Ethernet network is required for FT. This network must not be shared with other VMware features like HA.

☞ *"VMware Fault Tolerance takes high availability to the next level, completely eliminating downtime due to hardware failures with simplicity, at a low cost and across all applications, regardless of operating system."* [40]

[40] Cp. (VMware, Inc., 2009o), VMware data sheet: "VMware Fault Tolerance"

For more information

HP servers	http://www.hp.com/go/servers/
Data storage from HP	http://www.hp.com/go/storage
VMware vSphere	http://www.vmware.com/products/vsphere/
Alinean	http://www.alinean.com/

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